has an average rainfall of over 100 inches a year, while just east of the mountain range in the central part of the State the fall is less than fifteen inches.

I have been telling you some facts that you may already be familiar with, but my purpose has been to help you grasp the correlation of these phenomena in a large way. The whole chain of events can be very briefly exprest.

The source of all our weather changes is the sun. Its radiant energy warms the surface of the globe unequally. The air is warmed by conduction from or cooled by conduction to the warmer or cooler ground, respectively. Vertical and horizontal currents are set up in the air because of its expansion by warming or contraction by cooling, and are modified by the rotation of the earth. Ascending currents of air are rainy, descending currents are dry. The temperature of any place depends upon the latitude, elevation, slope or aspect of the surface, proximity to land and water, and prevailing winds. The rainfall is influenced by topography, prevailing winds, and the character of the country over which the winds blow.

The present movement to increase interest in nature study in our schools is an excellent one. The most successful men have been those who are most practical, men who can understand and make the most out of their environments.

The country boy is often more successful than the city bred boy partially because he has developed habits of personal observation and experience—because he has had natural and not artificial things around him. He sees nature in a large way and is quick to grasp conditions and foresee results.

Therefore the educational movement to teach all children something of the principles of growth and the conditions that promote or retard growth in both the animal and vegetable kingdoms is an excellent one.

We frequently hear of the college professor who pulled up his beans and planted them over again because they were coming wrong end up. Only a few days ago I read of the finding of a gate high up in a tree not far from Johnstown, Pa. The explanation given in the paper was that the gate had been carried down the stream during the damaging floods of a number of years ago, had lodged in the limbs of a small tree, and had been carried to its present great height as the tree had grown up. When your present nature-study plans have been fully developed no boy will grow up in such ignorance of the principles of plant growth as was indicated by this article. In all of your teaching in this direction the weather enters into your scheme more than any other factor, and it is one of the easiest to get valuable illustrations from.

The relation between the weather and the growth and yield of crops is very important from a practical point of view. For example, Professor Gibbs, of New Hampshire, and myself have determined that the yield of corn in the United States depends largely upon the July rainfall. From investigations in Ohio I have demonstrated that the poorest yields of oats are with warm, wet summers, and the best yields with cool, dry summers. Barley, on the other hand, does best in warm and dry weather and poorest in cool and wet summers. In South Australia, where they have 8 to 10 inches of rainfall a year, they can keep only 8 or 9 sheep for each square mile. In New South Wales, where the rainfall is 13 inches, they can keep 96 sheep on a square mile, and where it is 20 inches, 640 sheep. In Buenos Ayres, where the annual rainfall amounts to 34 inches, they can keep 2630 sheep on each square mile.

In Jamaica, when the rainfall for any year averages 56 inches, the average sugar export during the following season is 1441 casks per acre; when the rainfall is 76 inches, the export is 1559 casks, or about one-tenth more. This means an increase in the value of the sugar crop of about $400,000.

In Canada the school children have been encouraged to notice and report the blossoming of plants, leafing of trees, the coming of birds and insects, and the progress of farm work, to a far greater extent than has been done in the United States. They have a list of over one hundred things that can be reported on, and the school that makes the greatest number of reports and the individual scholar that makes the greatest number of reports is awarded a prize.

Observations of this character should be encouraged, and if any teacher wishes to take up such observations I shall be glad to assist in arranging the plan and the subjects to be considered.

All teachers in this State should take advantage of the agricultural extension work offered by the Ohio State University under the direction of Prof. A. B. Graham. The Agricultural Extension Bulletin that he publishes is of remarkable helpfulness in suggesting and directing plans and methods. Phenology, as it is called, relates to the study of the relation between weather and vegetation or animals, and one of the most fascinating branches of the study is that which relates to the effect of the weather on man.

Every teacher has experienced "cross-grained" or unruly days, when everything goes wrong, and it is probable that you have ascribed the trouble in some indefinite way as being due to the weather. But has it ever occurred to you that you might take some observations along this line that might be of direct value to science and to humanity?

During London fogs, and on days when the weather is particularly depressing, it is said that in the Bank of England, certain sets of books, an error in which would be accumulative and produce disastrous results farther on, are locked up, and the clerks set at tasks less intricate and important in character.

The same necessity for a cessation of certain lines of work during bad spells of weather is recognized by the large banking institutions in New York and other cities.

The head of a factory employing 3000 workman has said: "We reckon that a disagreeable day yields about 10 per cent less work than a delightful day, and we thus have to count this factor in our profit and loss account". But what is an "unfavorable" day and what is a "delightful" day? Prof. Cleveland Abbe, of Washington, and Mr. W. F. Tyler, of Shanghai, have suggested that we make out personal weather curves, of comfort or discomfort, by recording the different weather elements on days when we feel perfectly comfortable or exceedingly uncomfortable, unusually deprest or unduly elated.

Prof. Edwin Grant Dexter has investigated this subject quite carefully and has evolved many very interesting conclusions.

A RARE CUMULUS CLOUD OF LENTICULAR FORM.

By HENRY HELM CLAYTON. Dated Blue Hill Observatory, Hyde Park, Mass., May 8, 1906.

The accompanying figures 1, 2, and 3[1] present a rare cloud form photographed by Mr. Frederick Endicott, of Canton, Mass.,[2] about 1 p. m., on April 22, 1898. The form is one which has been named "lenticular cumulus" by Clement

[1] The same chimney pots appear in each of the photographs; in fig. 1 they are at the right edge, in fig. 2 somewhat to the left of the middle line, and in fig. 3 they are at the left edge. In fig. 1 a windmill shows the direction of the wind. The clouds moved in the same general direction. The cloud at the right in fig. 1 is the same as that on the left in fig. 2, and the cloud at the right in fig. 2 is the same as that at the right in fig. 3. The times of exposure were evidently in the order of the figures, 1, 2, and 3, since in each case the clouds drifted in the direction from the chimney pots indicated by the windmill.

The arrangement of the bases of the clouds in parallel bands shown on the right and on the left of figs. 1 and 2 indicates the presence of large atmospheric waves, of which these clouds probably formed the crest. This arrangement of the clouds in parallel bands is not uncommon in the case of ordinary cumulus. It is possible that the striations in the cloud were in some way related to the atmospheric waves.

[2] About three miles south-southwest of Blue Hill, Mass.

Ley. Clouds of this type are occasionally seen at Blue Hill and have been found associated with shallow secondaries in some part of a larger cyclone. In the present example the cloud resembles, but is not exactly like, the usual lenticular cumulus. It differs from the usual form in the fact that it appears to be composed of separate layers or thin plates growing smaller in diameter up to an apex at the top. It is the only example of this kind I have seen in twenty years of observation at Blue Hill, and I was very glad to learn that Mr. Endicott had succeeded in getting photographs of it. The photographs were taken at a point about three miles south-southwest of Blue Hill. These clouds were watched by me for several hours on the afternoon of April 22. They were found to be changing their forms slowly—not rapidly, like the ordinary cumulus. Blue Hill at the time was in the southern quadrant of an area of low pressure central off Nova Scotia. A second area of low pressure was approaching from the Mississippi Valley. The weather conditions at Blue Hill Observatory were a pressure about normal, a brisk west wind, a temperature of 57° F. and a dew-point of 26° F. Above the lenticular cumulus the sky was nearly covered with cirro-stratus. The cause of this particular cloud appears to have been local currents ascending from the heated ground like those which form ordinary cumulus, but the ascending currents had lost the turbulent uprush which forms the vortices and eddies of the ordinary cumulus. The condensation took place in thin disks which slowly pushed upward and evaporated.

The condition which favored the formation of this lenticular cloud was probably a condition in which the adiabatic rate of cooling for dry air extended to a great height, and the gradient went over by a gradual change from the adiabatic to the nonadiabatic condition, instead of suddenly as in the case of ordinary cumulus.

Knowing the temperature and the dew-point at the surface, the height of the base of the cloud can be computed, and is found to be about 2200 meters above Blue Hill, or 2400 meters above the adjacent sea level. This height is about twice that of ordinary cumulus. The reason that such clouds are rare is that it is very rare for the adiabatic rate of dry air to extend to so great a height. During the twelve years that observations with kites have been in progress at Blue Hill, only once has the adiabatic rate of dry air been found to extend upward to approximately this height from the ground. In that case also lenticular and turreted cumulus were observed. In the ordinary case, the ascending currents from the ground are interrupted in the midst of their uprush by an inverted gradient of temperature, caused by an overlying, potentially warmer stratum of air, at a height of some 500 to 1500 meters. I have found from the observations with kites that the stronger ascending currents, on account of their inertia, pass somewhat beyond the level of the inverted gradient and enter the warmer stratum, only to sink back again, so that quickly disappearing fracto-cumulus clouds sometimes form just above the level of the inverted gradient of temperature. These clouds are in such cases colder than the air at the same level, sometimes, indeed, as much as 10° colder. But as a rule this inverted gradient limits the height of the ascent of the locally heated, ascending columns of air, and, if the air is not damp enough to form cumulus clouds before the level of the inverted gradient is reached, none appear. For this reason the cumulus is usually found at the top of a turbulent uprush within 1500 meters of the ground, and not at a great height where the ascending currents have nearly exhausted their energy of ascent. After condensation begins in a cumulus cloud the rate of decrease of the temperature with height is much slower, so that the air currents can continue to rise through overlying strata where the decrease of temperature is comparatively slow, the ascent even going to very great heights as in shower clouds.

THE CAP CLOUD.

The preceding communication from Mr. Clayton, with the photographs by Mr. Endicott, relates to a form of cloud analogous to one that has been frequently observed by the Editor, and more especially during the cruise of the *Pensacola*, or the so-called U. S. Scientific Expedition to the west coast of Africa. One form of it was seen late in October, 1889, when we were lying at anchor off Horta, and the cloud itself enveloped the summit of Pico. The same form was seen very frequently in February, 1890, about 6 p. m., above the top of the mass of cumulus clouds that enveloped the summit of Green Mountain, on the island of Ascension, and in fact, on several occasions, it was seen to form like a shallow inverted saucer in mid-air, when no cumulus was in immediate contact. It was again seen in April, 1890, above great cumuli over the Bermudas. It was not seen in the drier climates of the African coasts, nor at any point within the United States, since I began to note cloud formations, in 1856. I had, therefore, formed the opinion that this "cap cloud", as I have always called it, was formed in a layer of very moist air, moving slowly, with very gentle vertical gradients and at very considerable altitudes. Such a moist current, flowing gently over the summit of Pico, late in the afternoon or early in the evening, when ascending currents from the warm ground are quite gentle, must itself be free from vortices or any other form of discontinuous motion, and must be characterized by what Kelvin calls lamellar motion, so that the successive layers of air, one above the other, move in gentle curves parallel to each other and, if they are pushed up high enough, become layers of delicate white cloud. The horizontal streaks and serrated or ragged ends of the clouds, as photographed by Mr. Endicott, were, I believe, always present in my cap clouds, and sometimes to a very marked degree; but I could never quite satisfy myself that in the cap cloud there really were several distinct layers superposed with intervening clear spaces, though the appearance suggested that this could easily have been the case.

Passing from the phenomenon over Pico to the regular daily appearance of the cap cloud over the cumuli at the island of Ascension, it was easily seen that the uprising column of air, constituting a cumulus, acts as an obstacle to the horizontal movement of the layer of air into which it intrudes. This layer must, therefore, rise slightly in order to surmount the obstacle, and in doing so forms a shallow inverted saucer cloud, whose only connection with the cumulus is that it surmounts the latter, being in fact formed in its own layer of air and often high above the obstacle. If the top of the cumulus is quite high and close to the cap cloud, there may seem to be no separation between them. I have recorded cases in which the standing waves of wind always present in the southeast trade to the leeward of Green Mountain, on Ascension, did not give rise to cumulus clouds in the late afternoon and early evening, because then there is no great vertical movement of moist air from the ocean surface. In such cases the summits of these invisible waves were surmounted by the saucer or cap cloud, standing still as a beautiful white object in mid-air—reminding one, in fact, of the ghosts of clouds after the sun has set and the great cumuli of daytime have disappeared.

As the conditions necessary to produce a gentle upward deflection—namely, moist air and steady horizontal winds at great elevations, the absence of strong vertical convection at those altitudes, and the presence of a mountain or a cumulus cloud mass—are not often conjoined, I think we may thus explain the rarity of this cloud in the Middle and Eastern States.

The umbrella clouds of M. Streit (Meteorologische Zeitschrift, January, 1896, Vol. XIII, p. 14) and W. D. Johnson (MONTHLY WEATHER REVIEW, May, 1898, Vol. XXVI, p. 207), the mushroom clouds of Professor Dr. Laska (Meteorologische Zeitschrift, January, 1899, Vol. XVI, p. 23), and the pyramid of cloud layers recorded by Hann (Meteorologische Zeitschrift, January, 1899, Vol. XVI, p. 25) all show that shallow cloudy layers may be produced by gentle overflow from the top of an ascending column of air, so that analogous clouds may be produced in various ways. We must, therefore, keep in mind the difference in origin between cap clouds and mushroom clouds.—*C. A.*

FIG. 1.—Lenticular cumulus.

FIG. 3.—Lenticular cumulus.

ABNORMAL WEATHER OVER SOUTHERN TEXAS.

By JOSEPH L. CLINE, Observer, Weather Bureau.

(Dated Corpus Christi, November 22, 1906.)

On Saturday, November 17, 1906, there was an area of low barometer over central Texas that caused abnormally high temperatures and clear weather over the southeastern portion of that State, while almost freezing and unsettled conditions prevailed over northwestern Texas. The maximum temperature on that date at Corpus Christi, was 91° F.; being 2° F. higher than the absolute maximum for the month of November since that station was established in February, 1887, and 1° to 3° F. higher than the maximum temperature for a great many of the months of July and August.

A cool wave of marked intensity followed this warm period and crost Texas on November 19. At 8 a. m.[1] of this date the barometric depression referred to above was central over the lower Rio Grande Valley, while the high barometer area and cool wave was central over southeastern Montana and extended east to the Mississippi Valley and south across the United States to central Texas, where it was raining, while it was snow-

[1] Seventy-fifth meridian time.